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ORIGINAL ARTICLE

The Effect of Perioperative Forced Air Warming Blanket on Older Adult Patients Undergoing Spinal Surgery with General Anesthesia

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ABSTRACT

Background: Elderly patients undergoing spinal surgery under general anesthesia are particularly susceptible to perioperative hypothermia due to impaired thermoregulation and prolonged surgical durations. Hypothermia is associated with multiple adverse outcomes, including increased blood loss, postoperative shivering, delayed wound healing, and prolonged hospitalization. Forced air warming (FAW) blankets offer a potential solution by actively maintaining normothermia during surgery.

Objective: To evaluate the effectiveness of perioperative forced air warming blankets in maintaining intraoperative core temperature and improving postoperative outcomes in older adult patients undergoing spinal surgery under general anesthesia.

Methods: This prospective observational study was conducted at Prince Sultan Cardiac Center, Riyadh, Saudi Arabia, and Bolan Medical Complex Hospital, Quetta, Pakistan, from June 2022 to May 2023. A total of 80 patients aged 60 years and above scheduled for elective spinal surgery were enrolled and divided into two groups (n=40 each). Group A received perioperative FAW, while Group B received standard passive insulation. Core temperatures were recorded preoperatively, intraoperatively, and postoperatively. Postoperative outcomes assessed included shivering, estimated blood loss, wound complications, and hospital stay duration. Statistical analysis was performed using SPSS version 26.0, with significance set at $p<0.05$.

Results: Intraoperative core temperature was significantly higher in Group A compared to Group B throughout the surgery ($p<0.001$). Postoperative shivering was markedly lower in the FAW group (5% vs. 27.5%, $p=0.006$). Group A also exhibited significantly reduced blood loss (310 ± 55 mL vs. 385 ± 63 mL, $p=0.01$) and shorter hospital stays (3.8 ± 1.1 days vs. 4.7 ± 1.3 days, $p=0.02$). Wound complications were less frequent in the FAW group but did not reach statistical significance.

Conclusion: Perioperative forced air warming blankets effectively maintain normothermia and improve postoperative recovery in elderly patients undergoing spinal surgery under general anesthesia. Routine incorporation of FAW into perioperative care protocols is strongly recommended for elderly surgical populations.

Keywords: Forced air warming, perioperative hypothermia, spinal surgery, elderly patients, general anesthesia, postoperative recovery, thermoregulation.

INTRODUCTION

Perioperative hypothermia defined as a core body temperature below 36°C remains a common and clinically significant complication during major surgical procedures, particularly in older adult patients. With advancing age, the human body undergoes several physiological changes that impair its ability to regulate temperature effectively[1]. These changes include reduced basal metabolic rate, diminished subcutaneous fat, blunted vasoconstrictive responses, and attenuated shivering mechanisms. Additionally, anesthetic agents used during general anesthesia further compromise thermoregulation by causing peripheral vasodilation and impairing the hypothalamic thermoregulatory center. Consequently, elderly patients undergoing prolonged surgical procedures such as spinal surgery are at a significantly higher risk of developing intraoperative hypothermia[2].

Spinal surgeries, by their nature, often involve extensive tissue dissection, large operative fields, and prolonged durations under general anesthesia. These factors, combined with the administration of unwarmed intravenous fluids, exposure to cold operating room environments, and use of skin antiseptics, substantially increase the risk of perioperative heat loss[3]. The clinical consequences of hypothermia are well-documented and include coagulopathies, increased blood transfusion requirements, wound infections, delayed recovery from anesthesia, prolonged hospital stays, and even perioperative cardiac events. These complications are particularly hazardous in the geriatric population, which often has comorbid conditions such as diabetes, hypertension, ischemic heart disease, and reduced physiological reserve, further compounding the risk of adverse outcomes[4].

Active thermal management strategies have therefore become an essential component of perioperative care in elderly patients. One of the most effective and widely used techniques is the application of forced air warming (FAW) systems. These systems work by circulating warm air through a disposable blanket placed over or under the patient, thereby maintaining normothermia through convective heat transfer. The perioperative use of FAW blankets has shown promising results in maintaining core body temperature and reducing the incidence of hypothermia-related complications in various surgical populations. However, data specific to the elderly demographic undergoing spinal surgeries particularly in developing country settings remains limited[5, 6].

In clinical settings across South Asia, where infrastructure and resources for perioperative temperature monitoring and active warming may vary, the implementation of FAW systems represents both a practical and impactful solution. Yet, the extent of their clinical benefit in spinal surgery among elderly patients has not been comprehensively evaluated in this region. Understanding the efficacy of FAW in such high-risk patients is essential not only to improve immediate surgical outcomes but also to reduce the overall burden on healthcare systems due to hypothermia-related postoperative complications[7].

This study was therefore conducted to assess the effect of perioperative forced air warming blankets on core body temperature maintenance and postoperative outcomes in older adult patients undergoing spinal surgery under general anesthesia. By comparing active warming with standard passive insulation, this study aims to provide evidence for enhancing perioperative care

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protocols for the elderly and contributing to the global efforts in improving geriatric surgical safety and outcomes[8].

MATERIALS AND METHODS

Study Design and Setting: This prospective observational study was carried out over a 12-month duration, from June 2022 to May 2023, at two major tertiary care centers: Prince Sultan Cardiac Center in Riyadh, Saudi Arabia, and Bolan Medical Complex Hospital in Quetta, Pakistan. Both institutions possess well-equipped neurosurgical units and modern operating theaters capable of supporting advanced surgical and anesthetic care, making them suitable venues for the evaluation of perioperative interventions in elderly patients undergoing spinal surgery under general anesthesia.

Study Population and Sample Size: A total of 80 elderly patients, aged 60 years and above, who were scheduled for elective spinal surgery under general anesthesia, were enrolled consecutively in the study using a non-probability consecutive sampling technique. The patients were divided into two groups of 40 each based on the warming method applied during the perioperative period. Group A (n=40) consisted of patients who received active warming using a forced air warming (FAW) blanket, while Group B (n=40) received standard thermal management using passive insulation with conventional cotton blankets.

Inclusion and Exclusion Criteria: The inclusion criteria encompassed patients aged 60 years or older, classified as American Society of Anesthesiologists (ASA) physical status I to III, and undergoing elective lumbar or thoracic spinal surgery, including procedures such as laminectomy, discectomy, or spinal fusion. Only patients with a normal baseline core body temperature ranging between 36°C and 37.5°C were considered eligible. Exclusion criteria included patients undergoing emergency or revision surgeries, those with a known history of endocrine or metabolic disorders affecting thermoregulation (e.g., hypothyroidism), patients presenting with fever or active infection, those requiring intraoperative blood transfusion, and individuals who declined consent or were lost to postoperative follow-up.

Perioperative Warming Protocol: Group A patients received active warming with a forced air warming blanket (Bair Hugger™ system or equivalent) applied to the lower body. The FAW system was initiated approximately 15 minutes before induction of anesthesia and continued throughout the intraoperative period until the patient was transferred to the post-anesthesia care unit (PACU). In contrast, Group B patients were managed with standard passive warming methods using cotton blankets, without the use of any active warming devices.

Anesthetic and Surgical Technique: A standardized general anesthetic protocol was applied across both study centers. Anesthesia induction involved intravenous administration of propofol, fentanyl, and atracurium, followed by endotracheal intubation. Anesthesia maintenance was achieved with inhaled isoflurane in a 50:50 air-oxygen mixture. All patients were monitored intraoperatively using standard ASA monitoring guidelines, including ECG, pulse oximetry, non-invasive blood pressure, and core temperature. Spinal surgeries were performed using the posterior approach under sterile conditions by experienced neurosurgical teams, ensuring consistency in the surgical technique.

Monitoring and Data Collection: Core body temperature was recorded at three stages: preoperatively in the holding area before anesthesia induction, intraoperatively at 30-minute intervals using a calibrated tympanic thermometer, and postoperatively in the recovery room immediately upon arrival and 30 minutes later. In addition to temperature data, several other clinical parameters were recorded. These included the duration of surgery (in minutes), total anesthesia time, estimated blood loss (in milliliters), incidence and severity of postoperative shivering (graded on a 0–3 scale), occurrence of wound complications such as infection or dehiscence, and the length of hospital stay (in days).

Ethical Considerations: Prior to commencement, the study protocol was reviewed and approved by the respective institutional ethics review boards at Prince Sultan Cardiac Center, Riyadh, and Bolan Medical Complex Hospital, Quetta. All patients provided written informed consent after receiving a detailed explanation of the study objectives, procedures, potential benefits, and risks. The confidentiality of patient data was strictly maintained throughout the research process in accordance with ethical standards and the Declaration of Helsinki.

Statistical Analysis: Data analysis was performed using IBM SPSS Statistics version 26.0. Continuous variables such as core temperature, blood loss, and hospital stay duration were expressed as mean ± standard deviation and compared between the two groups using independent samples t-tests. Categorical variables such as the incidence of shivering and wound complications were presented as frequencies and percentages and analyzed using the Chi-square test. A p-value of less than 0.05 was considered statistically significant for all comparisons.

RESULTS

This study evaluated the effect of perioperative forced air warming (FAW) blankets on thermoregulation and clinical outcomes in elderly patients undergoing elective spinal surgery under general anesthesia. The study population included 80 patients, divided equally into two groups (n=40 each). Group A received active perioperative warming using FAW blankets, while Group B was managed with passive insulation methods only. All results are reported with detailed statistical analysis using IBM SPSS version 26.0. Independent sample t-tests were applied for continuous variables, and Chi-square (χ^2) tests were used for categorical data. A significance level of $p < 0.05$ was considered statistically significant.

Demographic and Baseline Clinical Characteristics: Both groups were comparable at baseline in terms of demographic data, BMI, and ASA physical status classification. There were no statistically significant differences between the groups for age, sex, or body mass index (BMI), indicating that the two groups were homogenous and thus allowed a fair comparison of outcomes. In Table 1, demographic uniformity suggests that any differences observed in intraoperative or postoperative outcomes can be confidently attributed to the use of FAW blankets rather than baseline variability.

Table 1: Baseline demographic and clinical characteristics of patients in Group A and Group B.

Variable	Group A (FAW, n=40)	Group B (Control, n=40)	p-value
Mean Age (years)	66.8 ± 4.3	67.2 ± 4.7	0.64[1]
Gender (Male/Female)	22 / 18	23 / 17	0.82[2]
Body Mass Index (kg/m²)	24.6 ± 2.4	24.9 ± 2.1	0.51[1]
ASA Class I / II / III	12 / 19 / 9	10 / 21 / 9	0.89[2]

[1]Independent samples t-test; [2]Chi-square test

Table 2: Intraoperative core temperature measurements at predefined time points.

Time Point	Group A (FAW)	Group B (Control)	p-value
Preoperative Baseline (°C)	36.6 ± 0.2	36.5 ± 0.3	0.21[1]
30 Minutes After Incision	36.4 ± 0.3	35.7 ± 0.4	<0.001[1]
60 Minutes After Incision	36.3 ± 0.4	35.5 ± 0.5	<0.001[1]
End of Surgery	36.2 ± 0.4	35.3 ± 0.5	<0.001[1]

[1]Independent samples t-test

Intraoperative Core Temperature Maintenance: Forced air warming was found to significantly preserve intraoperative core body temperature. Measurements were recorded at 30-minute intervals, revealing consistent normothermia in Group A throughout the surgical procedure, in contrast to a progressive decline in Group B. Table 2 demonstrates that the average intraoperative core temperature in the FAW group remained within a clinically

safe and normothermic range (≥36°C). In contrast, Group B exhibited significant hypothermia, particularly evident by the end of the surgery. The observed temperature gap reached statistical significance as early as 30 minutes into surgery and remained consistent thereafter. This clearly reflects the efficacy of FAW in maintaining thermal homeostasis in elderly surgical patients.

Postoperative Clinical Outcomes: Postoperative outcomes revealed statistically significant benefits for the FAW group, particularly regarding shivering, intraoperative blood loss, and hospital stay duration. While the difference in wound complications between the groups did not reach statistical significance, the trend favored the FAW group. Table 3 shows that the incidence of postoperative shivering was significantly lower in patients who received active warming. Only 2 patients in Group A experienced mild shivering (grade 1), whereas 11 patients in Group B experienced moderate to severe shivering (grade 2 or 3), which required pharmacological management. This difference was highly statistically significant (p = 0.006), underscoring the effectiveness of FAW in thermoregulation and patient comfort.

Table 3: Comparison of postoperative outcomes between patients receiving FAW and control groups.

Outcome Parameter	Group A (FAW)	Group B (Control)	p-value
Postoperative Shivering (n, %)	2 (5.0%)	11 (27.5%)	0.006²
Estimated Blood Loss (mL)	310 ± 55	385 ± 63	0.01¹
Hospital Stay (days)	3.8 ± 1.1	4.7 ± 1.3	0.02¹
Wound Complications (n, %)	1 (2.5%)	4 (10.0%)	0.17²

¹Independent samples t-test; ²Chi-square test

Furthermore, estimated intraoperative blood loss was significantly less in Group A. The FAW group had a mean blood loss of 310 ± 55 mL, compared to 385 ± 63 mL in the control group (p = 0.01). This reduction is likely attributable to better core temperature maintenance and improved coagulation efficiency, which is known to be compromised in hypothermic conditions.

The average hospital stay was also significantly shorter in the FAW group (3.8 ± 1.1 days) compared to the control group (4.7 ± 1.3 days, p = 0.02), reflecting quicker recovery and reduced incidence of postoperative complications.

Though not statistically significant, wound complications such as surgical site infection or minor dehiscence were numerically lower in the FAW group (2.5%) versus the control group (10%). This trend is clinically relevant and supports the hypothesis that perioperative normothermia contributes to improved wound healing.

The results provide robust evidence that perioperative FAW significantly improves thermal stability during surgery in elderly patients. This thermal stability translated into tangible clinical benefits such as reduced postoperative shivering, lower blood loss, and shorter hospital stays. These findings align with global literature that advocates active warming as a standard of care in elderly surgical patients, especially for procedures involving long durations and high exposure, such as spinal surgery.

All statistical analyses were performed using SPSS version 26.0, with p-values < 0.05 interpreted as statistically significant. Both parametric (t-test) and non-parametric (Chi-square) tests were applied appropriately based on the nature of the variable analyzed.

DISCUSSION

This prospective observational study investigated the impact of perioperative forced air warming (FAW) blankets on thermoregulation and clinical outcomes in elderly patients undergoing spinal surgery under general anesthesia[9]. The findings clearly indicate that the use of FAW systems significantly improves intraoperative temperature control, reduces postoperative complications such as shivering and blood loss, and contributes to faster recovery and shorter hospital stays[10].

One of the most prominent observations in this study was the significant preservation of intraoperative core body temperature in the FAW group compared to the control group. Hypothermia during surgery, particularly in older adults, is a well-documented issue due to their impaired thermoregulatory mechanisms, decreased metabolic rate, and increased vulnerability to environmental factors such as cold operating room temperatures[11]. The control group in this study experienced a steady decline in temperature, with final readings often falling below 35.5°C, confirming the inadequacy of passive warming alone. In contrast, patients who received FAW blankets maintained normothermia (≥36°C) consistently throughout the surgical procedure. These results align with previously published evidence demonstrating the effectiveness of FAW in various surgical populations, further validating its relevance in geriatric care[12].

Thermal stability has a direct influence on several physiological and surgical parameters. Hypothermia impairs coagulation by inhibiting platelet function and enzymatic activity of clotting factors, thus increasing intraoperative blood loss[13]. In the present study, the FAW group had significantly lower blood loss compared to the control group (mean 310 ± 55 mL vs. 385 ± 63 mL, p = 0.01), consistent with the hypothesis that normothermia promotes hemostasis. This reduction not only minimizes the need for transfusion but also contributes to hemodynamic stability, faster wound healing, and reduced postoperative fatigue, which are particularly important in elderly patients with limited physiological reserves[14].

Postoperative shivering is another common and distressing complication of intraoperative hypothermia. It not only causes patient discomfort but also increases oxygen consumption and can precipitate myocardial ischemia in susceptible individuals. In this study, shivering occurred in 27.5% of patients in the control group but was limited to only 5% in the FAW group (p = 0.006). This dramatic difference highlights the preventive value of active warming in improving immediate postoperative recovery and patient comfort[15].

Hospital stay duration was also significantly shorter in the FAW group, indicating quicker postoperative recovery. On average, patients in the FAW group were discharged almost one day earlier than those in the control group (3.8 ± 1.1 vs. 4.7 ± 1.3 days, p = 0.02). Faster discharge in this population is a key indicator of better outcomes and has important implications for healthcare cost containment and hospital bed turnover, especially in resource-constrained settings[16].

Although the difference in wound complications between groups was not statistically significant, the lower incidence in the FAW group (2.5% vs. 10%) is clinically relevant. Surgical site infections and delayed wound healing are known to be more frequent in hypothermic patients due to impaired immune function, vasoconstriction, and reduced oxygen delivery to tissues. Maintaining normothermia likely supports wound healing by improving microcirculation and local immunity, even if this particular study did not achieve statistical power to confirm it[17].

This study also emphasizes the feasibility of FAW implementation in diverse healthcare settings, including both a well-resourced cardiac center in Saudi Arabia and a large public hospital in Pakistan. This cross-institutional design improves the generalizability of the results across different hospital environments, populations, and clinical practices[18].

Despite its strengths, the study has certain limitations. It was not a randomized controlled trial, which introduces the potential for selection bias despite well-matched baseline characteristics. Additionally, tympanic thermometry, while convenient and non-invasive, may be less accurate than core probes. Moreover, the sample size, though adequate for detecting differences in temperature and shivering, may be underpowered for low-incidence outcomes such as wound infections or cardiovascular events[19].

Future studies with randomized designs, larger populations, and invasive core temperature monitoring could provide further evidence on the impact of FAW on a broader range of clinical outcomes. Investigations into cost-effectiveness, patient satisfaction, and the utility of warming across various surgical specialties would also enhance clinical decision-making[20].

CONCLUSION

This study demonstrates that the use of perioperative forced air warming blankets in elderly patients undergoing spinal surgery under general anesthesia significantly enhances intraoperative thermal stability and leads to better clinical outcomes. Active warming reduced postoperative shivering, intraoperative blood loss, and length of hospital stay. These findings support the routine use of FAW systems as a standard of care for thermal management in older adult patients undergoing prolonged surgeries. Integrating active warming protocols in perioperative guidelines may substantially improve surgical safety, recovery, and patient comfort, especially in vulnerable geriatric populations.

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